

WHAT IS CLAIMED IS:

1. A doubles detection system for detecting doubled documents, the system comprising:

- 5 one or more light sources disposed on a first side of a test document;
- one or more reflected light sensors disposed along the first side of the test document, and adapted to generate one or more reflected light signals;
- one or more transmitted light sensors disposed along a second side of the test document, and adapted to generate one or more transmitted light signals;
- 10 a memory storing one or more master reflected light values and one or more master transmitted light values; and
- a processor adapted to
 - (1) receive the reflected light signal,
 - (2) generate a reflected light value for the test document,
 - 15 (3) calculate a reflectance ratio between the reflected light value of the test document and the master reflected light value,
 - (4) receive the transmitted light signal,
 - (5) generate a transmitted light value for the test document,
 - (6) adjust the master transmitted light value based on the reflectance ratio,
 - 20 (7) compare the adjusted master transmitted light value to the transmitted light value for the test document, and
 - (8) generate a doubles signal if the comparison of the adjusted master transmitted light value with the transmitted light value for the test document indicates that more than one document is present.

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2. The doubles detection system of claim 1 wherein the adjusted master transmitted light value determines a threshold for acceptable transmitted light values.

3. The doubles detection system of claim 2 wherein a test document having a
30 transmitted light value lower than the threshold is determined to be a doubled document.

4. The doubles detection of claim 3 wherein the doubled document is off-sorted into an output receptacle.
5. The doubles detection system of claim 1 wherein the master reflected light value and the master transmitted light value are input manually.
6. The doubles detection system of claim 1 wherein the master reflected light value and the master transmitted light value are determined in a learning mode.
- 10 7. The doubles detection of claim 7 wherein the master reflected light value and the master transmitted light value are determined, respectively, by averaging a plurality of individual reflected light values and individual transmitted light values for a series of master documents.
- 15 8. The doubles detection system of claim 1 wherein the master reflected light value and the master transmitted light value are determined, respectively, by averaging a plurality of individual reflected light values and individual transmitted light values for a series of test documents.
- 20 9. The doubles detection system of claim 1 wherein calculating the reflectance ratio comprises dividing the master reflected light value by the reflected light value of the test document.
10. The doubles detection system of claim 9 wherein adjusting the master transmitted light value comprises multiplying the master transmitted light value by the reflectance ratio.
- 25 11. The doubles detection system of claim 1 wherein calculating the reflectance ratio comprises dividing the reflected light value of the test document by the master reflected light value.
- 30 12. The doubles detection system of claim 11 wherein adjusting the master

transmitted light value comprises multiplying the master transmitted light value by an inverse of the reflectance ratio.

13. A method for detecting doubled documents comprising:
 - 5 illuminating a first side of a test document;
 - detecting at least one reflected light value from the first side of the test document;
 - detecting at least one transmitted light value from a second side of the test document;
 - calculating a reflectance ratio between a master reflected light value and the
 - 10 reflected light value for the test document;
 - adjusting a master transmitted light value based on the reflectance ratio;
 - comparing the adjusted master transmitted light value to the transmitted light value for the test document; and
 - generating a doubles signal if the comparison of the adjusted master transmitted
 - 15 light value with the transmitted light value for the test document indicates that more than one document is present.
14. The method of claim 13 further comprising off-sorting doubled documents in response to the doubles signal.
- 20 15. The method of claim 13 wherein calculating a reflectance ratio comprises dividing the master reflected light value by the reflected light value of the test document.
16. The method of claim 15 wherein adjusting the master transmitted light value
- 25 based on the reflectance ratio comprises multiplying the master transmitted light value by the reflectance ratio.
17. The method of claim 15 wherein adjusting the master transmitted light value based on the reflectance ratio comprises multiplying the master transmitted light value by
- 30 the square of the reflectance ratio.
18. The method of claim 13 wherein calculating a reflectance ratio comprises

dividing the reflected light value of the test document by the master reflected light value.

19. The method of claim 18 wherein adjusting the master transmitted light value based on the reflectance ratio comprises multiplying the master transmitted light value by an inverse of the reflectance ratio.

20. The method of claim 18 wherein adjusting the master transmitted light value based on the reflectance ratio comprises multiplying the master transmitted light value by the square of an inverse of the reflected light value.

21. A currency handling device comprising:
 a currency path adapted to transport a test document;
 at least one light source disposed on a first side of the currency path;
 at least one reflected light sensor disposed on the first side of the currency path
 and adapted to generate a reflected light signal for the test document;
 at least one transmitted light sensor disposed on a second side of the currency path and adapted to generate a transmitted light signal for the test document;
 a memory storing at least one master reflected light value and at least one master transmitted light value; and
 a processor electrically connected to:
 (a) the at least one reflected light sensor,
 (b) the at least one transmitted light sensor, and
 (c) the memory,
 the processor being adapted to access the master transmitted light value and adjust the master transmitted light value for the test document based on the reflected light signal for the test document.

22. The currency handling device of claim 21 wherein the memory stores a plurality of master reflected light values and a plurality of master transmitted light values, each pair of master reflected light values and master transmitted light values corresponding to a type and denomination of currency.

23. The currency handling device of claim 21 wherein the at least one reflected light sensor is a scanhead cell.

24. A doubles detection system for detecting doubled documents, the system comprising:

one or more light sources disposed on a first side of a test document;
one or more reflected light sensors disposed along the first side of the test document, and adapted to generate at least one reflected light signal;

one or more transmitted light sensors disposed along a second side of the test document, and adapted to generate at least one transmitted light signal;

a memory storing a master reflected light value and a master transmitted light value; and

a processor adapted to

(1) receive the reflected light signal,

(2) generate a reflected light value for the test document,

(3) calculate a reflectance ratio between the reflected light value of the test document and the master reflected light value,

(4) receive the transmitted light signal,

(5) generate a transmitted light value for the test document,

(6) adjust the transmitted light value for the test document based on the reflectance ratio,

(7) compare the adjusted transmitted light value for the test document to the master transmitted light value, and

(8) generate a doubles signal if the comparison of the adjusted transmitted light value for the test document with the master transmitted light value indicates that more than one document is present.

25. A method for detecting doubled documents comprising:

illuminating a first side of a test document;

detecting at least one reflected light value from the first side of the test document;

detecting at least one transmitted light value from a second side of the test document;

calculating a reflectance ratio between the master reflected light value and the reflected light value for the test document;

adjusting the transmitted light value for the test document based on the reflectance ratio;

5 comparing the adjusted transmitted light value for the test document to the master transmitted light value; and

generating a doubles signal if the comparison of the adjusted master transmitted light value with the transmitted light value for the test document indicates that more than one document is present.

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26. A document handling device comprising:

illuminating means for illuminating a test document from a first side of the test document;

15 reflected light sensing means for sensing light reflected from the first side of the test document and further for generating a reflected light signal;

transmitted light sensing means for sensing light transmitted through the test document to a second side of the test document and further for generating a transmitted light signal;

20 memory means for storing a master reflected light value and a master transmitted light value; and

a processor adapted to:

access the master transmitted light value,

receive the reflected light signal,

25 calculate a reflectance ratio based on the reflected light signal and the master reflected light value; and

adjust the master transmitted light value based on the reflectance ratio.

27. A method for analyzing documents in a document handling device comprising: sensing reflected light from a first side of a test document;

30 calculating a reflectance ratio based on a master reflected light value and the reflected light from the test document; and

adjusting a master transmitted light value based on the reflectance ratio.

28. A document handling device comprising:
- an input receptacle adapted to receive a stack of test documents;
 - a document transport mechanism adapted to transport the test document;
 - 5 a light source disposed along a first side of the document transport mechanism and adapted to direct light toward the bill transport mechanism and further adapted to illuminate the test document from a first side of the test document;
 - a reflected light sensor disposed along the first side of the document transport mechanism and adapted to generate an analog reflected light signal corresponding to the amount of light reflected from the first side of the test document;
 - 10 a transmitted light sensor disposed along a second side of the document transport mechanism and adapted to generate an analog transmitted light signal corresponding to the amount of light transmitted through the test document to a second side of the test document;
 - 15 at least one amplifier electrically connected to the reflected light sensor and the transmitted light sensor and adapted to amplify the analog light reflected light signal and the analog transmitted light signal;
 - an analog-to-digital converter electrically connected to the amplifier and adapted to convert the amplified analog reflected light signal into a digital reflected light signal and further adapted to convert the amplified analog transmitted light signal into a digital transmitted light signal;
 - 20 a memory adapted to contain a master reflected light value and a master transmitted light value associated with the type of the test document;
 - a processor electrically connected to the analog-to-digital converter and to the memory and adapted to:
 - (1) receive the digital reflected light signal,
 - (2) generate at least one reflected light value for the test document,
 - (3) access the memory to retrieve the master reflected light value and the master transmitted light value associated with the type of the test document;
 - 30 (4) calculate a reflectance ratio based on the reflected light value for the test document and the master reflected light value associated with the type of the test document;

- (5) receive the digital transmitted light signal;
- (6) generate at least one transmitted light value for the test document;
- (7) adjust the master transmitted light value based on the reflectance ratio,
- (8) compare the adjusted master transmitted light value to the transmitted light
- 5 value for the test document, and
- (9) generate a doubles signal if the comparison of the adjusted master transmitted light value with the transmitted light value for the test document indicates that more than one document is present; and
- an operator interface electrically connected to the processor and adapted to
- 10 receive the doubles signal and indicate the receipt of a doubles signal.

- 29. The device of claim 28 wherein accessing the memory to retrieve the master reflected light value and the master transmitted light value associated with the type of the test document comprises allowing a user to specify the type of the test document.
- 15 30. The device of claim 28 wherein accessing the memory to retrieve the master reflected light value and the master transmitted light value associated with the type of the test document comprises automatically determining the type of the test document.
- 20 31. The device of claim 30 wherein automatically determining the type of test document comprises comparing a pattern for the test document to stored patterns for a variety of types of documents.
- 32. A currency handling device comprising:
 - 25 a currency path adapted to transport test currency from a stack of test currency at a rate of at least about 800 bills per minute;
 - at least one light source disposed on a first side of the currency path;
 - at least one reflected light sensor disposed on the first side of the currency path and adapted to generate a reflected light signal for the test currency;
 - 30 at least one transmitted light sensor disposed on a second side of the currency path and adapted to generate a transmitted light signal for the test currency;
 - a memory storing at least one master reflected light value and at least one master

transmitted light value; and

a processor electrically connected to:

- (a) the at least one reflected light sensor,
- (b) the at least one transmitted light sensor, and

5 (c) the memory,

the processor being adapted to access the master transmitted light value and adjust the master transmitted light value for the test currency based on the reflected light signal for the test currency.

10 33. The currency handling device of claim 32 wherein the currency path is adapted to transport test currency from a stack of test currency at a rate of at least about 1200 documents per minute.

34. A document handling device comprising:

15 a document path adapted to transport test documents from a stack of test documents at a rate of at least about 800 documents per minute;

at least one light source disposed on a first side of the document path;

at least one reflected light sensor disposed on the first side of the document path and adapted to generate a reflected light signal for the test documents;

20 at least one transmitted light sensor disposed on a second side of the document path and adapted to generate a transmitted light signal for the test documents;

a memory storing at least one master reflected light value and at least one master transmitted light value; and

a processor electrically connected to:

25 (a) the at least one reflected light sensor,

(b) the at least one transmitted light sensor, and

(c) the memory,

the processor being adapted to access the master transmitted light value and adjust the master transmitted light value for the test document based on the reflected light signal for the test document.

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35. A method for analyzing currency in a currency handling device comprising:

sensing reflected light from a first side of a test currency bill;
 calculating a reflectance ratio based on a master reflected light value and the
 reflected light from the test document; and
 adjusting a master transmitted light value based on the reflectance ratio.

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36. A currency handling device comprising:

an input receptacle adapted to receive a stack of test currency bills;

a currency transport mechanism adapted to transport the test currency bills;

a light source disposed along a first side of the currency transport mechanism and

10 adapted to direct light toward the bill transport mechanism and further adapted to
 illuminate the test currency bills from a first side of the test currency bills;

a reflected light sensor disposed along the first side of the currency transport
 mechanism and adapted to generate an analog reflected light signal corresponding to the
 amount of light reflected from the first side of the test currency bills;

15 a transmitted light sensor disposed along a second side of the currency transport
 mechanism and adapted to generate an analog transmitted light signal corresponding to
 the amount of light transmitted through the test currency bills to a second side of the test
 currency bills;

20 at least one amplifier electrically connected to the reflected light sensor and the
 transmitted light sensor and adapted to amplify the analog light reflected light signal and
 the analog transmitted light signal;

25 an analog-to-digital converter electrically connected to the amplifier and adapted
 to convert the amplified analog reflected light signal into a digital reflected light signal
 and further adapted to convert the amplified analog transmitted light signal into a digital
 transmitted light signal;

a memory adapted to contain a master reflected light value and a master
 transmitted light value associated with the type of the test currency bill;

a processor electrically connected to the analog-to-digital converter and to the
 memory and adapted to:

- 30 (1) receive the digital reflected light signal,
 (2) generate at least one reflected light value for the test currency bill,
 (3) access the memory to retrieve the master reflected light value and the master

transmitted light value associated with the type of the test currency bill;

(4) calculate a reflectance ratio based on the reflected light value for the test currency bill and the master reflected light value associated with the type of the test currency bill;

- 5 (5) receive the digital transmitted light signal;
- (6) generate at least one transmitted light value for the test currency bill;
- (7) adjust the master transmitted light value based on the reflectance ratio,
- (8) compare the adjusted master transmitted light value to the transmitted light value for the test currency bill, and

- 10 (9) generate a doubles signal if the comparison of the adjusted master transmitted light value with the transmitted light value for the test currency bill indicates that more than one currency is present; and

 an operator interface electrically connected to the processor and adapted to receive the doubles signal and indicate the receipt of a doubles signal.

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37. The device of claim 36 wherein accessing the memory to retrieve the master reflected light value and the master transmitted light value associated with the type of the test currency bill comprises allowing a user to specify the type of the test currency bill.

- 20 38. The device of claim 36 wherein accessing the memory to retrieve the master reflected light value and the master transmitted light value associated with the type of the test currency bill comprises automatically determining the type of the test currency bill.

39. The device of claim 38 wherein automatically determining the type of test currency bill comprises comparing a pattern for the test currency bill to stored patterns for a variety of types of currency.
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